REMARKS

In view of the above amendments and the following remarks, reconsideration of the outstanding office action is respectfully requested. Pursuant to 37 CFR § 1.121, attached as Appendix A is a Version With Markings to Show Changes Made.

The rejection of claims 3, 20, and 23 under 35 U.S.C. § 112, second paragraph, for indefiniteness is respectfully traversed in view of the above amendments.

The rejection of claims 1-6 and 9 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,376,794 to Machi et al. ("Machi") is obviated in view of the cancellation of these claims.

The rejection of claims 1-5, 9, 15, 17, 19, 20, 23, 26, and 31 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,282,965 to Urairi et al. ("Urairi") is respectfully traversed in view of the above amendments and the following remarks. The rejection of claims 1-5 and 9 is obviated in view of the cancellation of these claims.

Urairi discloses a method for obtaining a membrane filter for liquids which has been rendered hydrophilic. The method includes rendering the surface of a fluorine-containing porous polymer membrane hydrophilic by treating the surface with a low temperature plasma under specific conditions.

In contrast, amended claim 15 (and its dependent claims 8, 17, and 19-30) is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane comprising: a) inserting a polymer membrane into a vacuum chamber and irradiating the surface of the polymer membrane with energized cationic particles under a high vacuum; and b) treating the surface-activated polymer membrane obtained in step a) by infusing a reactive gas onto the surface of the polymer membrane to cause reaction of the gas with the polymer membrane surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made" and amended claim 31 is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer comprising: a) inserting a polymer into a vacuum chamber and irradiating the surface of the polymer with energized cationic particles under high vacuum; and b) treating the surface-activated polymer obtained in step a) by infusing a reactive gas onto the surface of the polymer to cause reaction of the gas with the polymer surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made."

Urairi neither discloses nor suggests a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles, as required by claims 8, 15, 17, and 19-31 of the present application. In contrast, Urairi discloses treatment of the surface of a membrane with a low temperature plasma, which, as set forth at page 4 of the outstanding office action, includes both positive ions and electrons. In contrast to the method of the present invention, the use of a plasma, as disclosed in Urairi, leads to problems in control of uniformity due to plasma's inherent characteristics of high dependence on external environmental factors, broad energy distribution, etc., and enhanced potential for mechanical surface damage due to other side reactions degrading mechanical properties (see, e.g., Specification at page 3, line 29 to page 4, line 4).

In addition, Urairi neither discloses nor suggests treating the surface-activated polymer/polymer membrane by infusing a reactive gas onto the surface of the polymer/polymer membrane to cause reaction of the gas with the polymer surface, wherein the cationic beam irradiation and reactive gas infusion steps are sequentially made, as required by the claims of the present application. Therefore, the rejection based on this reference is improper and should be withdrawn.

The rejection of claims 1-6 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,885,077 to Karakelle et al. ("Karakelle") is obviated in view of the cancellation of the claims.

The rejection of claims 1-6, 15, 17-20, 23, 24, and 31 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,028,332 to Ohnishi et al. ("Ohnishi") is respectfully traversed in view of the above amendments and the following remarks. The rejection of claims 1-6 is obviated in view of the cancellation of these claims.

Ohnishi relates to a method of manufacturing a hydrophilic material, the resulting material, and its use for porous membranes. The method involves subjecting at least part of the surfaces of a membrane substrate of a polymer material to a plasma treatment to thereby produce a polymer radical on the surfaces and graft polymerizing with the polymer radical a block copolymer containing a hydrophilic monomer supplied in the gaseous phase and a subsequently supplied hydrophobic monomer.

In contrast, amended claim 15 (and its dependent claims 8, 17, and 19-30) is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane comprising: a) inserting a polymer membrane into a vacuum chamber and irradiating the surface of the polymer membrane with energized cationic particles under a high vacuum; and b) treating the surface-activated polymer membrane obtained in step a) by infusing a reactive gas onto the surface of the polymer membrane to cause reaction of the gas with the polymer membrane surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made" and amended claim 31 is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer comprising: a) inserting a polymer into a vacuum chamber and irradiating the surface of the polymer with energized cationic particles under high vacuum; and b) treating the surface-activated polymer obtained in step a) by infusing a reactive gas onto the surface of the polymer to cause reaction of the gas with the polymer surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made."

Ohnishi neither discloses nor suggests a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles, as required by claims 8, 15, 17, and 19-31 of the present application. In contrast, Ohnishi discloses subjecting the surface of a polymer material to a plasma treatment, which, as set forth at page 4 of the outstanding office action, includes both positive ions and electrons. In contrast to the method of the present invention and as described above, the use of a plasma, as disclosed in Ohnishi, leads to problems in control of uniformity due to plasma's inherent characteristics of high dependence on external environmental factors, broad energy distribution, etc., and enhanced potential for mechanical surface damage due to other side reactions degrading mechanical properties (see, e.g., Specification at page 3, line 29 to page 4, line 4).

Therefore, the rejection based on this reference is improper and should be withdrawn.

The rejection of claims 1-3, 6, 8, 15, 17-20, 23, 24, 27, and 31 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,845,132 to Masuoka et al. ("Masuoka") is respectfully traversed in view of the above amendments and the following remarks. The rejection of claims 1-3 and 6 is obviated in view of the cancellation of the claims.

Masuoka teaches a hydrophilic porous membrane, a plasma separator using the hydrophilic porous membrane, and a method of producing a hydrophilic porous membrane by irradiating the outer surface of a hydrophobic porous membrane with plasma, feeding hydrophilic monomer in a gaseous state, and allowing the hydrophilic monomer to be graft polymerized on the surface of the porous membrane. Masuoka teaches that the hydrophilic porous membrane exhibits prominent dimensional stability and strength while in use, and discloses a blood plasma separator that uses the hydrophilic porous membrane.

In contrast, amended claim 15 (and its dependent claims 8, 17, and 19-30) is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane comprising: a) inserting a polymer membrane into a vacuum chamber and irradiating the surface of the polymer membrane with energized cationic particles under a high vacuum; and b) treating the surface-activated polymer membrane obtained in step a) by infusing a reactive gas onto the surface of the polymer membrane to cause reaction of the gas with the polymer membrane surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made" and amended claim 31 is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer comprising: a) inserting a polymer into a vacuum chamber and irradiating the surface of the polymer with energized cationic particles under high vacuum; and b) treating the surface-activated polymer obtained in step a) by infusing a reactive gas onto the surface of the polymer to cause reaction of the gas with the polymer surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made."

Masuoka neither discloses nor suggests a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles, as required by claims 8, 15, 17, and 19-31 of the present application. In contrast, Masuoka discloses irradiating a hydrophobic porous membrane with plasma, which, as set forth at page 4 of the outstanding office action, includes both positive ions and electrons. In contrast to the method of the present invention and as described above, the use of a plasma, as disclosed in Masuoka, leads to problems in control of uniformity due to plasma's inherent characteristics of high dependence on external environmental factors, broad energy distribution, etc., and potential for mechanical surface damage due to other side reactions degrading mechanical properties (see, e.g., Specification at page 3, line to page 4, line 4).

Therefore, the rejection based on this reference is improper and should be withdrawn.

The rejection of claims 1-5, 9, 15-26, and 29-31 under 35 U.S.C. § 103(a) as being unpatentable over Korean Laid-Open Patent Publication No. 96-37742 ("Publication No. 96-37742"), as discussed on page 4 of the specification, in view of Machi is respectfully traversed in view of the above amendments and the following remarks. The rejection of claims 1-5 and 9 is obviated in view of the cancellation of these claims.

Publication No. 96-37742, as described at page 4 of the specification, relates to a method for reforming a polymer surface by irradiating it with energized ion particles under vacuum conditions while at the same time infusing reactive gas into the polymer surface.

Machi discloses a process for the production of a separator for use in a cell which includes irradiating a polymer film with ionizing radiation, contacting the irradiated film with an aqueous solution of a terminally unsaturated monomer to cause grafting of the monomer onto the film, and then treating the grafted film with an aqueous alkali solution.

It is the position of the U.S. Patent and Trademark Office ("PTO") that Publication No. 96-37742 teaches the method steps of the present invention, but does not specifically mention treating polymer membranes, polyolefin blends, or laminates. However, the PTO argues that it would have been obvious to one skilled in the art to employ polymers in the form of polymeric membranes, as disclosed by Machi, as the polymer to be treated in the process disclosed by Publication No. 96-37742. Applicants respectfully disagree.

In contrast to the disclosures of Publication No. 96-37742 and Machi, amended claim 15 (and its dependent claims 8, 17, and 19-30) is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane comprising: a) inserting a polymer membrane into a vacuum chamber and irradiating the surface of the polymer membrane with energized cationic particles under a high vacuum; and b) treating the surface-activated polymer membrane obtained in step a) by infusing a reactive gas onto the surface of the polymer membrane to cause reaction of the gas with the polymer membrane surface, <u>wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made</u>" (emphasis added) and amended claim 31 is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer comprising: a) inserting a polymer into a vacuum chamber and irradiating the surface of the polymer with energized cationic particles under high vacuum; and b) treating the surface-activated polymer obtained in step a) by infusing a reactive gas onto the surface of the polymer to cause reaction of the gas with the polymer surface, <u>wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made</u>" (emphasis added). Neither Publication No. 96-37742 nor Machi disclose or suggest a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles and infusing a reactive gas onto the surface of the polymer membrane or polymer, wherein the cationic beam irradiation and reactive gas infusion are sequentially made, as required by claims 15 and 31, and their dependent claims.

In particular, Publication No. 96-37742 discloses irradiating a polymer surface with energized ion particles while at the same time infusing reactive gas into the polymer surface. There is no disclosure or suggestion in Publication No. 96-37742, as disclosed at page 4 of the specification, relating to a sequential process including first irradiating a polymer/polymer membrane surface and then infusing a reactive gas onto the surface of the polymer/polymer membrane. In contrast, Publication No. 96-37742, as disclosed at page 4 of the specification, specifically discloses simultaneous irradiation and infusion of a reactive gas.

In addition, Machi discloses irradiation of the surface of a membrane and contacting the irradiated film with an aqueous solution of a terminally unsaturated monomer.

Accordingly, since neither Publication No. 96-37742 nor Machi disclose or suggest a sequential process including first irradiating a polymer/polymer membrane surface with energized cationic particles and then infusing a reactive gas onto the surface of the polymer/polymer membrane, as required by the claims of the present invention, this rejection is improper and should be withdrawn.

The rejection of claims 1-6, 9, 15, 17, 19-27, and 29-31 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,965,629 to Jung et al. ("Jung") in view of Machi is respectfully traversed in view of the above amendments and the following remarks. The rejection of claims 1-6 and 9 is obviated in view of the cancellation of these claims.

Jung relates to a process for modifying the surfaces of a polymer, ceramic, indium-tin-oxide (ITO), or glass by irradiating energized ion particles onto the surfaces of the polymer, ceramic, ITO, or glass while blowing a reactive gas directly over the surface of the polymer, ceramic, ITO, or glass under a vacuum condition.

It is the position of the U.S. Patent and Trademark Office ("PTO") that Jung teaches the method steps of the present invention, but does not specifically mention treating polymer membranes, polyolefin blends, or laminates. However, the PTO argues that it would have been obvious to one skilled in the art to employ polymers in the form of polymeric membranes, as disclosed by Machi, as the polymer to be treated in the process disclosed by Jung. Applicants respectfully disagree.

In contrast to the disclosures of Jung and Machi, amended claim 15 (and its dependent claims 8, 17, and 19-30) is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane comprising: a) inserting a polymer membrane into a vacuum chamber and irradiating the surface of the polymer membrane with energized cationic particles under a high vacuum; and b) treating the surface-activated polymer membrane obtained in step a) by infusing a reactive gas onto the surface of the polymer membrane to cause reaction of the gas with the polymer membrane surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made" (emphasis added) and amended claim 31 is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer comprising: a) inserting a polymer into a vacuum chamber and irradiating the surface of the polymer with energized cationic particles under high vacuum; and b) treating the surface-activated polymer obtained in step a) by infusing a reactive gas onto the surface of the polymer to cause reaction of the gas with the polymer surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made" (emphasis added). Neither Jung nor Machi disclose or suggest a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles and infusing a reactive gas onto the surface of the polymer membrane or polymer, wherein the cationic beam irradiation and reactive gas infusion are sequentially made, as required by claims 15 and 31, and their dependent claims.

In particular, Jung discloses irradiating a polymer surface with energized ion particles while at the same time blowing a reactive gas over the polymer surface. There is no disclosure or suggestion in Jung relating to a sequential process including first irradiating a polymer/polymer membrane surface and then infusing a reactive gas onto the surface of the polymer/polymer membrane. In contrast, Jung specifically discloses simultaneous irradiation and infusion of a reactive gas.

In addition, as described above, Machi discloses irradiation of the surface of a membrane and contacting the irradiated film with an aqueous solution of a terminally unsaturated monomer.

Accordingly, since neither Jung nor Machi disclose or suggest a sequential process including first irradiating a polymer/polymer membrane surface with energized cationic particles and then infusing a reactive gas onto the surface of the polymer/polymer membrane, as required by the claims of the present invention, this rejection is improper and should be withdrawn.

The rejection of claims 1-6, 9, 15, 17, 19-27, and 31 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,783,641 to Koh et al. ("Koh") in view of Machi is respectfully traversed in view of the above amendments and the following remarks. The rejection of claims 1-6 and 9 is obviated in view of the cancellation of these claims.

Koh relates to a process for modifying a polymer surface by irradiating energized ion particles on the polymer surface, while blowing a reactive gas directly on the polymer surface under vacuum condition.

It is the position of the U.S. Patent and Trademark Office ("PTO") that Koh teaches the method steps of the present invention, but does not specifically mention treating polymer membranes, polyolefin blends, or laminates. However, the PTO argues that it would have been obvious to one skilled in the art to employ polymers in the form of polymeric membranes, as disclosed by Machi, as the polymer to be treated in the process disclosed by Koh. Applicants respectfully disagree.

In contrast to the disclosures of Koh and Machi, amended claim 15 (and its dependent claims 8, 17, and 19-30) is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane comprising: a) inserting a polymer membrane into a vacuum chamber and irradiating the surface of the polymer membrane with energized cationic particles under a high vacuum; and b) treating the surface-activated polymer membrane obtained in step a) by infusing a reactive gas onto the surface of the polymer membrane to cause reaction of the gas with the polymer membrane surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made" (emphasis added) and amended claim 31 is directed to "[a] method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer comprising: a) inserting a polymer into a vacuum chamber and irradiating the surface of the polymer with energized cationic particles under high vacuum; and b) treating the surface-activated polymer obtained in step a) by infusing a reactive gas onto the surface of the polymer to cause reaction of the gas with the polymer surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made" (emphasis added). Neither Koh nor Machi disclose or suggest a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles and infusing a reactive gas onto the surface of the polymer membrane or polymer, wherein the cationic beam irradiation and reactive gas infusion are sequentially made, as required by claims 15 and 31, and their dependent claims.

In particular, Koh discloses irradiating a polymer surface with energized ion particles while at the same time blowing a reactive gas over the polymer surface. There is no disclosure or suggestion in Koh relating to a sequential process including first irradiating a polymer/polymer membrane surface with energized cationic particles and then infusing a reactive gas onto the surface of the polymer/polymer membrane. In contrast, Koh specifically discloses simultaneous irradiation and infusion of a reactive gas.

In addition, as described above, Machi discloses irradiation of the surface of a membrane and contacting the irradiated film with an aqueous solution of a terminally unsaturated monomer.

Accordingly, since neither Koh nor Machi disclose or suggest a sequential process including first irradiating a polymer/polymer membrane surface with energized cationic particles and then infusing a reactive gas onto the surface of the polymer/polymer membrane, as required by the claims of the present invention, this rejection is improper and should be withdrawn.

The rejection of claim 8 under 35 U.S.C. § 103(a) as being unpatentable over Publication No. 96-37742, as discussed on page 4 of the specification, Jung, or Koh, each in view of Masuoka as applied to claim 1, and further in view of U.S. Patent No. 4,346,142 to Lazear et al. ("Lazear") is respectfully traversed in view of the above amendments and the following remarks.

Lazear discloses a process for rendering a normally hydrophobic polyolefinic open cell microporous film relatively permanently hydrophilic, improving the water flow rate there through, and reducing the electrical resistance thereof by chemically fixing a controlled amount of at least one hydrophilic organic hydrocarbon monomer to the surface of the micropores of the film with ionizing radiation. In particular, Lazear discloses coating the surface of the micropores of the microporous film with a hydrophilic monomer or mixture thereof, and subsequently exposing the coated microporous film to ionizing radiation.

As described above, none of Publication No. 96-37742, as discussed on page 4 of the specification, Jung, Koh, or Masuoka disclose or suggest a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles and infusing a reactive gas onto the surface of the polymer membrane or polymer, wherein the cationic beam irradiation and reactive gas infusion are sequentially made, as required by claim 8.

Moreover, Lazear does not disclose a sequential process including first irradiating a polymer/polymer membrane surface with energized cationic particles and then infusing a reactive gas onto the surface of the polymer/polymer membrane. In contrast, Lazear specifically discloses first coating a microporous film with a hydrophilic monomer, and subsequently exposing the coated microporous film to ionizing radiation. Further, there is no suggestion or motivation to combine the references found in the references themselves or in the state of the art. The only basis for the combination of a sequential process including first irradiating a polymer/polymer membrane surface with energized cationic particles and then infusing a reactive gas onto the surface of the polymer/polymer membrane is applicants' combination of these elements. Therefore, this rejection is improper and should be withdrawn.

The rejection of claims 1-7, 15-25, and 27-31 under 35 U.S.C. § 103(a) as being unpatentable over Masuoka is respectfully traversed in view of the remarks above.

The rejection of claim 8 under 35 U.S.C. § 103(a) as being unpatentable over Machi or Masuoka in view of Lazear is respectfully traversed.

As described above, none of Machi, Masuoka, or Lazear disclose or suggest a method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane or polymer which includes irradiating the surface of the polymer membrane or polymer with energized cationic particles and infusing a reactive gas onto the surface of the surface-activated polymer membrane or polymer, wherein the cationic beam irradiation and reactive gas infusion are sequentially made, as required by claim 8. Moreover, there is no suggestion or motivation to combine the references found in the references themselves or in the state of the art. The only basis for the combination of a sequential process including first irradiating a polymer/polymer membrane surface with energized cationic particles and then infusing a reactive gas onto the surface of the polymer/polymer membrane is applicants' combination of these elements. Therefore, this rejection is improper and should be withdrawn.

The rejection of claim 7 under 35 U.S.C. § 103(a) as being unpatentable over Machi is obviated in view of the cancellation of this claim.

The rejection of claim 7 under 35 U.S.C. § 103(a) as being unpatentable over Masuoka is obviated in view of the cancellation of this claim.

In view of all of the foregoing, applicants submit that this case is in condition for allowance and such allowance is earnestly solicited.

Respectfully submitted,

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Appendix A

Version With Markings to Show Changes Made

In reference to the amendments made herein to claims 8, 15, 17, 19, 20, 22, 23, and 31, additions appear as underlined text, while deletions appear as bracketed text, as indicated below:

In The Claims:

8. (Amended) [A] The method in accordance with claim [1] 15, wherein the polymer membrane is a microporous film manufactured either by a dry process where pores are formed by low and high temperature stretching or by a wet process where material of low molecular weight is extracted to form pores.

15. (Twice-Amended) A method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer membrane comprising:

a) inserting a polymer membrane into a vacuum chamber and irradiating the surface of the polymer membrane with energized [ionic] cationic particles under a high vacuum [and under conditions effective to change pore size and shape of the polymer membrane]; and

b) treating the surface-activated polymer membrane obtained in step a) by infusing a reactive gas onto the surface of the polymer membrane to cause reaction of the gas with the polymer membrane surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made.

17. (Twice-Amended) The method in accordance with claim 15, wherein the reactive gas infusion of step b) is made without interference of the [ionic] cationic particles.

19. (Twice-Amended) The method in accordance with claim 15, wherein energized [ionic] cationic particles of step a) are irradiated on one side or two sides of the polymer membrane.

20. (Twice-Amended) The method in accordance with claim 15, wherein the [ionic] cationic particles of step a) are produced from one or more ion generating gases selected from the group consisting of [electron,] hydrogen, oxygen, helium, nitrogen, oxygen, air, fluorine, neon, argon, krypton, N_20, and their mixtures.

22. (Twice-Amended) The method in accordance with claim 15, wherein the energy of [ionic] cationic particles of step a) is from 10^{-2} to 10^{7} keV.

23. (Twice-Amended) The method in accordance with claim 15, wherein the high vacuum of step [b)] a) is 10^{-2} to 10^{-8} torr.

31. (Twice-Amended) A method for providing hydrophilicity or increased hydrophobicity to the surface of a polymer comprising:

a) inserting a polymer into a vacuum chamber and irradiating the surface of the polymer with energized [ionic] cationic particles under high vacuum [and under conditions effective to change pore size and shape of the polymer]; and

b) treating the surface-activated polymer obtained in step a) by infusing a reactive gas onto the surface of the polymer [membrane] to cause reaction of the gas with the polymer surface, wherein the cationic beam irradiation of step a) and reactive gas infusion of step b) are sequentially made.